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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER
DAY, HERNG DER

ART UNIT	PAPER NUMBER
2123	7

DATE MAILED: 09/05/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/491,353	CIRAK ET AL.	
	Examiner	Art Unit	
	Hemg-der Day	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 July 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-7,9-23,25 and 26* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7,9-23,25 and 26* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a)☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1)☒ Notice of References Cited (PTO-892)
2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3)☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4)☐ Interview Summary (PTO-413) Paper No(s). _____ .
5)☐ Notice of Informal Patent Application (PTO-152)
6)☐ Other: .

DETAILED ACTION

1. This communication is in response to Applicants' Response (paper # 6) to Office Action dated March 19, 2003 (paper # 5), faxed July 21, 2003.

1-1. Claims 1, 9, and 16-17 have been amended; claims 8 and 24 have been cancelled; claims 25-26 have been added; claims 1-7, 9-23, and 25-26 are pending.

1-2. Claims 1-7, 9-23, and 25-26 have been examined and claims 1-7, 9-23, and 25-26 have been rejected.

Abstract

2. The Examiner has acknowledged without objection that the abstract has been amended.

Specification

3. The Examiner requests copies of the following publications referred to in the original specification because they appear to be reasonably necessary to the examination of this application and cannot be found.

(1) J. Warren, "Subdivision methods for geometric design", Unpublished manuscript, Department of Computer Science, Rice University, November 1995, referred to in line 23 of page 22 through line 1 of page 23.

(2) J.E Schweitzer, "Analysis and Application of Subdivision Surfaces", Ph.D. dissertation, Department of Computer Science and Engineering, University of Washington, Seattle, 1996, referred to in lines 11-13 of page 23.

4. The amendment filed July 21, 2003, is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The amended material, which does not appear to be supported by the original disclosure, is as follows:

(1) Added "to form weights for the final surface" to the amended claim 1, step (c), as described in page 2 of paper # 6.

Applicant is required to cancel the new matter in the reply to this Office Action.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 1-7 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

6-1. Claim 1 recites the limitation "to form weights for the final surface" in step (c) of the claim, which does not appear to be supported by the original specification.

6-2. Claims 2-7 are rejected as being dependent on the rejected claim 1.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

8. Claim 26 is rejected under 35 U.S.C. 102(a) as being anticipated by Mandal et al., "A Novel FEM-Based Dynamic Framework for Subdivision Surfaces", Proceedings of the fifth ACM Symposium on Solid Modeling and Applications, June 1999, pages 191-202.

8-1. Regarding claim 26, Mandal et al. disclose a method comprising:

first, including a control mesh indicative of a surface to be modeled (control mesh, page 193, column 1, section 1, last paragraph);

intuitively subdividing said control mesh to form a subdivision surface which is based iteratively on the previous mesh and which has vertices which are based on vertices of the 1-neighborhood (The (Modified) Butterfly Subdivision, page 193, section 2.1); and

continuing said intuitively subdividing until a surface which has specified smoothness is obtained (produces a smooth C^1 surface in the limit, page 193, column 2, paragraph 2).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 1-2, 4-5, 9-10, 12-13, 17-18, and 20-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Groothuis et al., U.S. Patent 5,581,489 issued December 3, 1996, in view of Nasri et al., "An Algorithm for Interpolating Intersecting Curves by Recursive Subdivision Surfaces", Proceedings, Shape Modeling International '99, International Conference on Shape Modeling and Applications, March 1999, pages 130-137, 274.

10-1. Regarding claim 1, Groothuis et al. disclose a method of performing finite element analysis on a shell including (abstract; and summary, column 1 line 47 through column 2, line 27):

(a) modeling a geometry of the shell using subdivision surfaces (subdivisions, column 3, lines 61-65);

(b) characterizing an environment for the shell, including environmental factors affecting the mechanical behavior of a modeled shell (materials information, column 4, lines 13-30);

(c) computing a mechanical response of the modeled shell, taking into account the characterized environment, using a finite element analysis to form weights for the final surface (finite element analysis processor, column 5, lines 30-43; density of the material, column 4, lines 21-30; form weights is inherently included in the mechanical response of a finite element analysis, e.g., stress analysis); and

(d) outputting a description of the geometry of the modeled shell as determined from the computed mechanical response (displays, column 5, lines 47-54).

Groothuis et al. fail to expressly disclose using subdivision surfaces of a type formed by recursively subdividing a mesh to form a smoothed surface. Nevertheless, Groothuis et al. do

suggest using subdivisions to define either smaller areas or smaller volumes (subdivisions, column 4, lines 50-54).

Nasri et al. teach how a recursive subdivision surface can be described and performed. At the limit, the sequence P_i converges to a smooth surface (Nasri, page 1, column 1, section 1, paragraph 1). Nasri et al. also disclose, "Interpolation conditions on recursive subdivision surfaces provide more powerful techniques to manipulate such surfaces" (Nasri, abstract). Specifically, Nasri et al. disclose the missing element:

(a) modeling a geometry of the shell using subdivision surfaces of a type formed by recursively subdividing a mesh to form a smoothed surface (Nasri, recursive subdivision surface, page 1, column 1, section 1, paragraph 1, and abstract).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Groothuis et al. to incorporate the teachings of Nasri to obtain the invention as specified in claim 1 because, as Nasri et al. described, "Interpolation conditions on recursive subdivision surfaces provide more powerful techniques to manipulate such surfaces" (Nasri, abstract).

10-2. Regarding claim 2, Groothuis et al. further disclose the environment factors includes loading conditions, material properties, and boundary conditions for the modeled shell (input data, column 3, lines 58-61; and thermal output data, column 4, line 62 through column 5, line 3).

10-3. Regarding claim 4, Groothuis et al. further disclose the loading conditions include an indication of thermal loading (thermal output data, column 4, line 62 through column 5, line 3).

10-4. Regarding claim 5, Groothuis et al. further disclose outputting indications of the characterized environment (output data, column 5, lines 11-29; and displays, column 5, lines 47-54).

10-5. Regarding claims 9-10 and 12-13, these system claims include equivalent method limitations as in claims 1-2 and 4-5 and are unpatentable using the same analysis of claims 1-2 and 4-5.

10-6. Regarding claims 17-18 and 20-21, these computer program claims include equivalent method limitations as in claims 1-2 and 4-5 and are unpatentable using the same analysis of claims 1-2 and 4-5.

11. Claims 3, 11, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combined teachings of Groothuis et al., U.S. Patent 5,581,489 issued December 3, 1996, and Nasri et al., "An Algorithm for Interpolating Intersecting Curves by Recursive Subdivision Surfaces", Proceedings, Shape Modeling International '99, International Conference on Shape Modeling and Applications, March 1999, pages 130-137, 274, as applied to claims 1, 9, and 17, and further in view of Buchanan, "Schaum's Outline of Theory and Problems of Finite Element Analysis", The McGraw-Hill Companies, Inc., 1995.

11-1. Regarding claim 3, Groothuis et al. disclose a method of generating a model of an object for use in finite element analysis (abstract). Groothuis et al. suggest the result of a finite element analysis is to predict the effect on an object of heat transfer, mechanical stress, and thermal stress (column 1, lines 43-45). However, Groothuis et al. only emphasize the analysis of heat transfer and thermal stress instead of mechanical stress, Groothuis et al. fail to expressly disclose the loading conditions include an indication of applied forces.

Buchanan discloses a solved mechanical stress problem to explain the application of the finite element analysis to plate-bending problems. In the exemplary problem, the square plate is simply supported with a 1000-lb load applied at the center node (problem 7.18, page 231). It indicates that including applied forces, therefore, is inherent in solving mechanical stress problem by finite element analysis.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combined teachings of Groothuis et al. and Nasri et al. and to incorporate the teachings of Buchanan to obtain the invention as specified in claim 3 because Buchanan discloses in detail the loading conditions include an indication of applied forces, which is inherent in solving mechanical stress, for example, thin-plate bending, problems.

11-2. Regarding claim 11, this system claim includes equivalent method limitations as in claim 3 and is unpatentable using the same analysis of claim 3.

11-3. Regarding claim 19, this computer program claim includes equivalent method limitations as in claim 3 and is unpatentable using the same analysis of claim 3.

12. Claims 6-7, 14-15, 22-23, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combined teachings of Groothuis et al., U.S. Patent 5,581,489 issued December 3, 1996, and Nasri et al., "An Algorithm for Interpolating Intersecting Curves by Recursive Subdivision Surfaces", Proceedings, Shape Modeling International '99, International Conference on Shape Modeling and Applications, March 1999, pages 130-137, 274, as applied to claims 1, 9, and 17, and further in view of Applicants' assertion.

12-1. Regarding claims 6 and 7, Groothuis et al. disclose using one of several commercially available finite element analysis processors (column 1, lines 24-32). However, Groothuis et al.

fail to expressly disclose the finite element analysis uses (1) subdivision basis functions as shape functions; (2) suitably smooth shape functions.

The fundamental concept of the finite element method is well known. Each element is defined using an interpolation function to describe its behavior between its nodes. The shape function is usually the coefficient that appears in the interpolation polynomial and is written for each individual node of a finite element. Therefore, using shape function is necessary and inherent in finite element analysis. Applicants present and discuss prior art shape functions in appendix of the specification (pages 42-44).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combined teachings of Groothuis et al. and Nasri et al. and to incorporate the prior art shape functions disclosed in the Applicants' specification to obtain the invention as specified in claims 6 and 7 because using shape function is necessary and inherent in finite element analysis.

12-2. Regarding claims 14 and 15, these system claims includes equivalent method limitations as in claims 6 and 7 and are unpatentable using the same analysis of claims 6 and 7.

12-3. Regarding claims 22 and 23, these computer program claims includes equivalent method limitations as in claims 6 and 7 and are unpatentable using the same analysis of claims 6 and 7.

12-4. Regarding claim 25, Groothuis et al. fail to expressly disclose intuitively subdividing each surface and repeatedly refining the mesh until a surface with C1 smoothness is obtained.

Applicants assert in the original specification, as described in lines 21-23 of page 1, "It is well-known from approximation theory that in this context, the convergence of finite-element solutions requires so-called C^1 interpolation".

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combined teachings of Groothuis et al. and Nasri et al. and to incorporate the Applicants' assertion of the convergence requirement to obtain the invention as specified in claim 25 because the convergence of the finite-element solution is guaranteed.

13. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Buchanan, "Schaum's Outline of Theory and Problems of Finite Element Analysis", The McGraw-Hill Companies, Inc., 1995, in view of Nasri et al., "An Algorithm for Interpolating Intersecting Curves by Recursive Subdivision Surfaces", Proceedings, Shape Modeling International '99, International Conference on Shape Modeling and Applications, March 1999, pages 130-137, 274.

13-1. Regarding claim 16, Buchanan discloses a system for performing finite element analysis using subdivision basis functions, including:

(a) means for inputting a mesh comprising a set of data points each having connectivity to neighboring data points, the mesh defining physical parameters (Fig. 7-11, page 230);

(b) means for specifying an initial state for the mesh (Fig. 7-11, page 230; and problem 7.18, page 231);

(c) means for defining a set of linear differential equations comprising a stiffness matrix and an external forcing vector (stiffness matrix and load vector, solution 7.18, page 231), at least one such equation having a fourth order differential operator (the governing equation for plate bending is a fourth-order differential equation, section 7.7, page 210);

(d) means for solving the set of linear equations as applied to the mesh (results are given, solution 7.18, page 231);

(e) means for outputting the solution to the set of linear equations as defining a modification of the initial state of the mesh based on the stiffness matrix and in response to the external forcing vector (Table 7.4, page 232).

Buchanan fails to expressly disclose based on subdivision surfaces which are recursively formed from an initial mesh and which produce a smoothed surface description.

Nasri et al. teach how a recursive subdivision surface can be described and performed. At the limit, the sequence P_i converges to a smooth surface (Nasri, page 1, column 1, section 1, paragraph 1). Nasri et al. also disclose, "Interpolation conditions on recursive subdivision surfaces provide more powerful techniques to manipulate such surfaces" (Nasri, abstract). Specifically, Nasri et al. disclose the missing element:

(e) based on subdivision surfaces which are recursively formed from an initial mesh and which produce a smoothed surface description (Nasri, recursive subdivision surface, page 1, column 1, section 1, paragraph 1, and abstract).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Buchanan to incorporate the teachings of Nasri to obtain the invention as specified in claim 16 because, as Nasri et al. described, "Interpolation conditions on recursive subdivision surfaces provide more powerful techniques to manipulate such surfaces" (Nasri, abstract).

Applicant's Arguments

14. Applicants argue the following:

(1) Groothuis does teach subdividing, however, it does not teach the special subdivision surfaces (pages 10-11, paper # 6).

(2) "Specifically, claim 1 has been amended to recite that the subdivision surface is iteratively subdivided. Claim 9 has been amended to recite that the subdivision surfaces are iteratively formed to produce a smoothed surface. None of this is in any way taught or suggested by the cited prior art." (pages 11-12, paper # 6).

Response to Arguments

15. Applicants' arguments have been fully considered and are persuasive. Therefore, the rejections of claims 1-24 under 35 U.S.C. 102(b) and 103(a) in paper # 5 have been withdrawn. However, upon further consideration, a new ground(s) of rejection is made, as detailed in sections **7** to **13-1** above.

Conclusion

16. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Reference to DeRose et al., U.S. Patent 6,037,949 issued March 14, 2000, and filed August 4, 1997, is cited as disclosing a subdivision process.

17. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Herng-der Day whose telephone number is (703) 305-5269. The examiner can normally be reached on 9:00 - 17:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin J Teska can be reached on (703) 305-9704. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 746-7239 for regular communications and (703) 746-7238 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-3900.

Herng-der Day
September 1, 2003

HUGH JONES PH.D.
PRIMARY PATENT EXAMINER
TECHNOLOGY CENTER 2100